

APPENDIX E: CONSTRUCTION CARBON FOOTPRINT CALCULATIONS

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The project's carbon emissions from construction was estimated by calculating the total weight of CO₂-equivalent emitted as exhaust from expected construction equipment, on-site passenger vehicles, and commute vehicles during all phases of construction. Using project conceptual designs and fill requirements (volumes to be excavated, imported, and graded) a DWR Division of Engineering (DOE) construction project manager estimated crew size, equipment needs, and duration of operation for each phase of construction. The design requirements included:

- Alternative 1 – onsite excavation, distribution and grading of 1.18 million cubic yards (M yd³) of fill;
- Alternative 2 –importation and distribution of 500,000 yd³ of fill from the adjacent ISD property, and onsite excavation, distribution, and grading of 1.18 M yd³ for a total grading volume of 1.68 M yd³; source yet to be determined), and onsite excavation, distribution and grading of 1.3 M yd³, for a total grading volume of 3 M yd³.

DOE Project Estimates

DOE estimated an average 3.5-minute fill transport circuit between the project site and the ISD source. By applying the 25 yd³ scraper capacity to the circuit time, an import schedule of 73 days was calculated as follows:

- $60 \text{ min} / (3.5 \text{ min/cycle}) = 17.14 \text{ cycles/hr} \times 8 \text{ hrs} = 137.14 \text{ cycles (loads)/day}$
- $137.14 \text{ loads/day/scraper} \times 2 \text{ scrapers} = 274.29 \text{ loads/day} \times 25 \text{ yd}^3/\text{load}$
 $= 6,857 \text{ yd}^3/\text{day}$
- $500,000 \text{ yd}^3 / (6,857 \text{ yd}^3/\text{day}) = 72.92 \text{ days} \sim 73 \text{ days}$

For on-site grading, channel excavation and other minor activities (irrigation system removal, vegetation grubbing, levee breaching, placement of geo-textiles, etc.), DOE provided the following subjective estimates based on best professional opinion:

- Alt. 1 – 30 day schedule operating a motor grader, 2 small dozers, 3 excavators and a water truck for normal 8-hour shifts.
- Alt. 2 – Double the equipment for the effort estimated in Alt. 1 above.

Alternatives Analysis

Using fuel consumption rates provided by the Caterpillar Performance Handbook, and presumptions for passenger vehicles, estimated total consumption of diesel and unleaded fuel was calculated. World Resources Institute/World Business Council for Sustained Development GHG Protocol *CO₂ emissions from transport or mobile sources* calculation tool was used to convert diesel and unleaded totals into GHG emissions (CO₂-Equivalent). The methods are described in more detail for each alternative below.

Alternative 1 – For purposes of this analysis, an oversized crew of 17 was presumed necessary to operate construction equipment and perform on-site supervision by contractors and local/state

project officers over the course of 30 days. Average commute distance was presumed to be 35 miles (based on distances connecting: Oakley, CA and Stockton, CA; and Oakley and Antioch, CA), with an average fuel efficiency rate of 17 mpg. Four on-site observation and supervisor's vehicles were presumed to be driven 5 miles per day at 10 mpg. Planting of the restored tidal wetland, following most construction activity, will take three months with the same crew size and passenger vehicle fleet demand aforementioned in this alternative. Again, this alternative does not involve fill imports.

Fuel consumption for Alternative 1 was calculated as follows:

On-site excavation, transportation, distribution and contouring:

30 days x 8 hrs/day = 240 hrs for each piece of equipment

240 hrs motor grader x 9 g/hr x (1) = 2,160 g. diesel

240 hrs small dozer x 19 g/hr x (2) = 9,120 g.

240 hrs excavator x 9 g/hr x (3) = 6,480 g.

240 hrs water truck x 8 g/hr x (1) = 1,920 g.

Total estimated diesel = 19,680 gallons

On-site Observation and Construction Supervisor vehicles:

(4 p x 30 days) = 120 person-days x (5 miles/day)/10 mpg = 60 g. unleaded

Commute to/from project site for all staff:

(17 p x 30 days) = 510 person-days x (35 miles/day)/17 mpg = 1050 g. unleaded

Post-construction planting:

60 g./month + 1050 g./month = 1110 g. unleaded/month x 3 months = 3330 g. unleaded

Total estimated unleaded: 60 + 1050 + 3330 = 4440 gallons

Carbon dioxide equivalent (CO₂-Eq.) from combustion exhaust was calculated as follows:

19,680 g. diesel x 0.1404235 GJ/gal x (74.01 kgCO₂/GJ)/1000 = 204.5 Metric tons CO₂-Eq.

4,440 g. unleaded x 0.130204 GJ/gal x (69.25 kgCO₂Eq./GJ)/1000 = 40.03 Metric tons CO₂-Eq.

Total CO₂-Eq. (Alt. 1) = 204.5 + 40.03 = 244.53 Metric tons CO₂-Eq.

Alternative 2 – Importation of 500,000 yd³ of material from ISD, and grading of a total of 1.68 M yd³ of material. DWR estimates 73 8-hour days utilizing 3 scrapers to complete the importation. The construction equipment used in Alternative 1 would be doubled in order to utilize the same 30-day schedule and crew size of 17 persons in order to undertake the anticipated amount of grading. Commute and on-site passenger vehicle consumption was based on the mileage and efficiencies listed above.

Fuel consumption for Alternative 2 was estimated as follows:

Transportation of fill from ISD:

73 days x 8 hrs/day x 3 scrapers = 1,752 hrs x 21 gph = 36,792 g. diesel

On-site excavation, transportation, distribution and contouring:

30 days x 8 hrs/day = 240 hrs for each piece of equipment:

240 hrs motor grader x 9 g/hr x (1) = 2,160 g. diesel

240 hrs small dozer x 19 g/hr x (2) = 9,120 g.

240 hrs excavator x 9 g/hr x (3) = 6,480 g.

240 hrs water truck x 8 g/hr x (1) = 1,920 g.

Total, this section: 19,680 g. diesel x 2 sets of equip. = 39,360 g. diesel

Total estimated diesel: 36,792 + 39,360 = 76,152 g.

On-site Construction Supervisor vehicles:

(4 p x 103 days) = 412 person-days x (5 miles/day)/10 mpg = 206 g. unleaded

Commute to/from project site:

(17 p x 103 days) = 1751 pers-days x (35 miles/day)/17 mpg = 3,605 g. unleaded

Post-construction planting:

60 g. + 1050 g. = 1110 g. unleaded/month x 3 months = 3330 g. unleaded

Total estimated unleaded: 206 + 3605 + 3330 = 7141 g.

Carbon dioxide equivalent (CO₂-Eq.) from combustion exhaust was calculated as follows:

76,152 g. diesel x 0.1404235 GJ/gal x (74.01 kgCO₂/GJ)/1000 = 791.43 Metric tons CO₂-Eq.

7141 g. unleaded x 0.130204 GJ/gal x (69.25 kgCO₂Eq./GJ)/1000 = 64.39 Metric tons CO₂-Eq.

Total CO₂-Eq. (Alt. 2) = 791.43 + 64.39 = 855.82 Metric tons CO₂-Eq.

Alternative 3 – Total grading of 3 M yd³ of fill; of which 500,000 yd³ of fill would be imported from ISD, and 1.2 million yd³ of fill would be imported from a more distant source. GHG emissions were not calculated for this alternative since additional source(s) of fill have not been designated. Along with greatly increased operating costs associated with the transport of a large quantity of fill from an offsite source(s), we would expect a related increase in the size of the project's carbon footprint.

Sources:

Caterpillar Performance Handbook, Edition 38. 2008. Caterpillar, Inc.

CO₂ emissions from transport or mobile sources calculation tool, Version 1.3. June 2005. World Resources Institute/World Business Council for Sustained Development GHG Protocol Initiative.

<http://www.ghgprotocol.org/calculation-tools/all-tools> (registration required)